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Towards the Next Generation of Scenario Walkthrough Tools – A Research Preview

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Abstract. **[Context and motivation]** With the rise of cyber-physical systems (CPS), smart ecosystems, and the Internet of Things (IoT), software-intensive systems have become pervasive in everyone's daily life. The shift from software systems to ubiquitous adaptive software-intensive systems not only affects the way we use software but further has an impact on the way these systems are designed and developed. Gathering requirements for such systems can benefit from elicitation processes that are conducted in the field with domain experts. **[Question/problem]** More traditional elicitation approaches such as interviews or workshops exhibit limitations when it comes to gathering requirements for systems of this nature – often lacking an in-depth context analysis and understanding of contextual constraints which are easily missed in a formal elicitation setting. Furthermore, dedicated methods which focus on understanding the system context such as contextual design are not widely adopted by the industry as they are perceived to be time-consuming and cumbersome to apply. **[Principal ideas/results]**. In this research preview paper we argue that scenario-based RE, scenario walkthrough approaches in particular, have the potential to support requirements elicitation for ubiquitous adaptive software-intensive systems through facilitating broader stakeholder involvement and enabling contextual requirements elicitation within the workplace of future system end-users. The envisioned on-site scenario walkthroughs can either be conducted by an analyst or by future end-users of the system themselves. **[Contribution]** We describe a research agenda including our ongoing research and our efforts to develop a novel framework and tool support for scenario-based RE.

Keywords: Contextual requirements elicitation · Scenario-based RE · Society

1 Introduction and Motivation

Discovering, analyzing, and specifying requirements is of utmost importance for successful software- and systems engineering [10,12]. However, traditional requirements elicitation approaches (e.g., interviews and workshops) exhibit various limitations when it comes to the design and development of ubiquitous, adaptive software-intensive systems such as cyber-physical systems (CPS), smart ecosystems, cloud systems, and applications for the Internet of Things (IoT). There is a need for methods which are better-suited for gathering requirements from a large number of diverse stakeholders, require lower effort, and can be applied remotely [17]. Furthermore, a deep understanding of contextual issues is beneficial for the development of such systems [6] and contextual constraints can be easily missed in a more formal elicitation setting. Existing contextual requirements engineering methods such as contextual design [2] are often time-consuming to apply and are therefore not widely used in industry.

In this research preview paper, we argue that scenario-based RE, in particular, scenario walkthrough approaches have the potential to support requirements elicitation for ubiquitous adaptive software-intensive systems. We foresee different ways in which scenario walkthroughs can facilitate broader stakeholder involvement and create a more engaging requirements elicitation process. These include workshops with selected stakeholders as well as on-site scenario walkthroughs conducted either by an analyst or directly by end-users of the future systems. We furthermore envision that scenario tools would not only be applied during system design time, but could allow end-users and other stakeholders to continuously provide feedback and generate new ideas during system run time in order to support system evolution. These ideas are based on previous work and experiences in the field, as scenario-based RE has a long established tradition of using walkthroughs to support requirements elicitation and scenario validation within workshop settings and even on-site [1,7,8,15,19]. However, techniques developed a decade ago were based on technologies that simply were not mature enough at that time, rendering the successful, large-scale adoption of these approaches difficult if not infeasible.

In Sect. 2 we look back at seminal related work in the field of scenario-based RE, discuss limitations of previous scenario-based approaches, and identify new opportunities introduced by recent technological advances. Section 3 presents our research agenda and highlights research questions to drive future research in scenario-based RE. In Sect. 4 we present early research results in the form of a novel scenario tool prototype which will be the basis for evaluating scenario-based requirements discovery in different settings. Finally, Sect. 5 concludes this paper.

2 Looking Back a Decade: Earlier Tools and Limitations

Scenarios are used in diverse ways throughout the software system development life cycle, including requirements elicitation, negotiation, modelling, and specification [1]. The work presented in this paper focuses on scenario-based RE for

the discovery of requirements – a field of research which has not received much attention from the RE community in recent years.

One of the leading tool environments, that was also applied in industrial projects, was ART-SCENE (Analyzing Requirements Tradeoffs – Scenario Evaluation) [7]. ART-SCENE was a simple-to-use tool environment which allowed the specification of Use Cases and the generation of normal and alternative course scenarios. ART-SCENE-based scenario walkthroughs were mainly conducted in workshop settings where a facilitator used the ART-SCENE Scenario Presenter to walk through the generated scenarios and to explore what-if questions with key stakeholders [7]. Additionally, ART-SCENE extensions also included multimedia representations of scenarios which were designed to improve the discovery of requirements [19].

ART-SCENE extensions also included an ART-SCENE variant for Personal Digital Assistants (PDAs) which enabled analysts to conduct scenario walkthroughs on-site, in the workplace of future system users [8,15]. These walkthroughs with the so-called Mobile Scenario Presenter (MSP) were successful in terms of requirements knowledge discovered [8,15]. However, at this time, mobile technologies were still in their infancy. Technological constraints, including the limited availability of suitable devices to run the mobile scenario-based tool, made it cumbersome for analysts to collect requirements on-site [8,15]. Furthermore, due to limited availability of mobile internet and the overall limited usability of software running on these devices, mobile scenario-based requirements elicitation remained a niche domain that did not gain broader attention.

Now, over a decade later, many of the previous hardware-imposed limitations have been resolved. Mobile devices, such as smartphones and tablets, are used on a daily basis, even by non-technical users, mobile internet is available almost anywhere, and cloud-based services allow fast access and storage of data.

However, due to the importance of contextual RE [6], other RE approaches making use of mobile devices have been developed. This for example includes the iRequire [14] approach, which focuses on end-users and allows them to take pictures of the system context and document text based requirements, but lacks end-user guidance and does not include underlying contextual models. Other approaches focusing on system evolution such as the ConTexter approach [18] use GPS positions of predefined objects to gather structured feedback on IT Ecosystems. In recent years several feedback approaches allowing end-users to give feedback on software systems have been developed (e.g., [5,11]). The evaluation of such approaches indicates that end-users are able to gather requirements for future systems. However, to the best of our knowledge, none of these existing mobile approaches are based on scenarios. Therefore, re-visiting (on-site) scenario-based requirements elicitation, which provides focus and structure in the form of scenarios and adopting it to today's environment and system needs is a timely, and worthwhile endeavor.

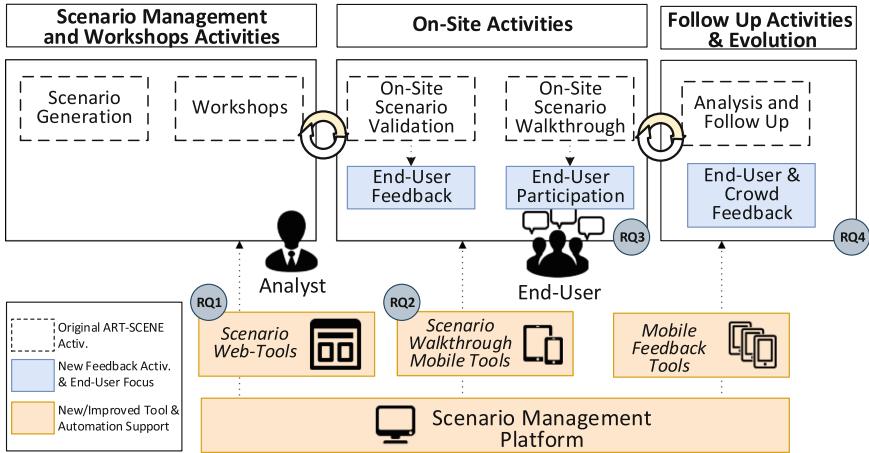


Fig. 1. Overview of the envisioned scenario-based RE framework.

3 Research Agenda

Our proposed research on scenario-based RE is driven by four key ideas: (1) the extension and reuse of scenario-based RE, making use of novel technologies (e.g., smartphones) and (2) its application within new domains. We further strive to (3) include end-users, who have previously been neglected, in the scenario-based requirements discovery process and (4) study the suitability of scenarios regarding new development paradigms (Fig. 1).

More specifically, we pursue the following research questions (RQ):

RQ1: To what extent can novel tools and techniques, built over current technologies, overcome the limitations of scenario walkthroughs as experienced in the past? With this first research question we focus on leveraging past experiences [8, 15] and transition from old technologies such as PDAs to new up-to-date technologies such as smartphones, tablets and other mobile devices, as well as cloud-based computing. The research objective thus is to develop a framework and tool prototypes that leverage new technologies to address past limitations.

RQ2: What is the impact of using scenario-based approaches on the development of ubiquitous adaptive software-intensive systems from an analyst' point of view? We frame the second objective to investigate the suitability of the framework by applying it to different kinds of systems and by evaluating the usability and usefulness of the tools via user studies (e.g., using the cognitive dimensions of notations framework [3, 13]). We present our initial prototype of the framework and tools alongside an initial application scenario in Sect. 4.

RQ3: To what extent can our novel scenario tools be used by non-RE experts such as (future) system end-users? In a second phase we will go beyond the initial scope and capabilities of scenario-based walkthroughs and actively involve end-users in the scenario generation and validation process.

RQ4: How can a scenario-based approach be integrated with modern development paradigms and support the ongoing evolution of software systems? Historical scenario-based approaches were designed at a time when more linear development processes, such as waterfall or the Unified Process (i.e., longer iterations), were common. However, we aim to explore integration of the scenario-based approach into new development paradigms, including rapid prototyping, agile software development, rapid release cycles, and DevOps. This will include to actively involve end-users and incorporating crowd-based feedback mechanisms [9, 16] for existing features and also for iterative improvements to the overall systems.

4 NextGen Scenario-Based Requirements Discovery

As part of our initial effort to re-create and extend the previous scenario-based and mobile requirements tools [8, 15] we developed an initial proof-of-concept framework supporting the generation, validation, and walkthrough of scenarios, for use in workshops and on-site. The prototype implementation currently includes key features available in the previous ART-SCENE solution. We developed a cloud-based web tool for generating new scenarios, and for managing existing ones, documenting individual steps for scenarios and generating “what-if” questions based on these scenarios. Secondly, a mobile application allows the on-site use of these scenarios by providing views that enable step-by-step walkthroughs of a scenario, commenting on individual steps, and adding diverse multimedia attachments such as images. A screenshot of the scenario management tool, alongside the mobile view is depicted in Fig. 2.

As part of our initial evaluation, we plan to use the tool-supported approach for understanding the system context and gathering requirements for

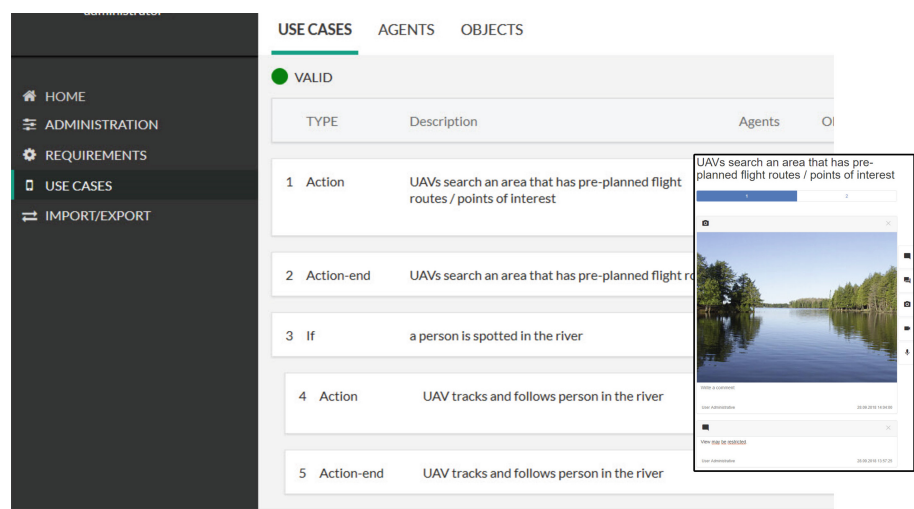


Fig. 2. Scenario management tool & mobile scenario tool prototype.

the Dronology system, a platform for managing, coordinating, and controlling unmanned aerial vehicles (UAV's) with support for collaborative tasks [4].

In a first pilot study the prototype tool was used by the authors to create initial scenarios for a community project which were validated in a workshop and used to capture requirements on-site. Workshop participants included city representatives, first-responders and firefighters, who discussed scenarios and necessary steps to use UAVs to support river-search-and-rescue and medical supply delivery. We found that the tool allowed us to create scenarios for the different UAVs use cases, and to capture requirements regarding their usage, deployment, and management on-site and in real-time.

Based on the feedback received during the pilot study and our ideas for how to further improve our prototype, we plan to redesign the user interface and improve the usability of the tool. A key goal is to develop a user interface which focuses on end-user needs, allowing them to use the tool without the help of an analyst. Furthermore, we are planning to make use of mobile positioning and tracking technologies (e.g., GPS) to trigger events automatically and document the geographic location of requirements. Another envisioned feature is to use the mobile device's sensors to capture contextual information (e.g., WiFi reception strength, proximity to other devices). This more advanced prototype will provide the basis for a fully fledged user study. In a first phase, we plan an evaluation of the prototype stakeholders of the Dronology project in workshops and on-site meetings. In a second phase, we will provide the prototype to future end-users of the Dronology system (e.g., firefighter) to document their requirements for the system.

In the more distant future, we plan to use the prototype in other projects and we will also explore new features such as integrating augmented reality or video-based approaches.

5 Conclusion

In this paper we present our ideas and initial results towards a new framework supporting scenario-based requirements elicitation. We build upon experiences from our previous work in this area nearly a decade ago and aim to overcome previous technical limitations by using new technologies. We further aim towards extending previous scenario-based approaches, for example by actively involving end-users in collecting requirements and providing feedback to existing or newly developed features. Finally, as part of our ongoing research we have started to evaluate the approach in context of smart- and cyber-physical systems.

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